Skill Builder 2: Turning

Overview:

Students will write a program on their calculator to turn the Rover left and right at various angles. They are challenged to make their Rover slowly turn like the hands of clock and to report the time of day on their calculator.

Goals:

Students will:

1. write a TI BASIC program to turn Rover left or right at different angles.
2. incorporate the For…End control structure into a program.
3. incorporate the Output(I/O statement into a program.
4. make a model of a clock using the Rover.

Background:

The Rover turns by rotating its wheels in opposite directions at the same speed at the same time. This type of turn is called a spin because it spins in a circle that has a center at the midpoint of the two wheels. This midpoint is also the location of the marker tip when a dry-erase marker is inserted into the pen holder. When the Rover performs a turn, the program needs to inform the motors the direction and size of the spin. The direction is determined by LEFT or RIGHT, this direction is from the view of as if Rover had a driver's seat. The size of the turn is determined by the angle, this is a value in degrees, radians, or gradians. A full spin is 360 degrees. This number is from the base 60 sexagecimal system used by the Sumerians in ancient Babylon. Similarly, a full spin is 2π radians. This number comes from the fact that the angular width of an arc of one radius in length along the circumference of any circle is defined as one radian. Also, a full spin is 400 gradians. The grad is defined in the metric system as 1/100 of a circle quadrant. The Rover can accept all three units when an angle is given using the key words of DEGREES, RADIANS and GRADS.

Rover Command	Example	Behavior
RV LEFT *angle* SPEED *speed* UNIT	RV LEFT	Rover makes a left hand* 90˚ spin The LEFT command is available from the Hub-Rover-Drive menu.
RV RIGHT *angle* SPEED *speed* UNIT	RV RIGHT	Rover makes a right hand* 90˚ spin The RIGHT command is available from the Hub-Rover-Drive menu.
	RV LEFT 45	Rover makes a 45˚ left hand spin
	RV RIGHT 3.14 RADIANS **	Rover makes a π radians (180◦) right hand spin The RADIANS keyword is available from the Hub-Rover-Settings menu.
	RV RIGHT 200 GRAD ***	Rover makes a 200 gradians (180˚) right hand spin
	RV LEFT 180 SPEED .14 M/S ****	Rover makes a slow 180˚ left hand turn
	RV RIGHT 180 SPEED .23 M/S ****	Rover makes a fast 180˚ right hand turn

* The LEFT and RIGHT turns are made with a frame of reference from Rover's driver's seat.

** Radians is an angular unit of measure used in mathematics. There are 2π RADIANS in 360˚ DEGREES.

*** Gradians is an angular unit of measure also used in mathematics. There are 100 GRADIANS in a quarter circle; hence 400 grads in a full circle.

**** The maximum speed is .23 M/S and the minimum is .14 M/S.

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Setup Rover:	Supplies:
Students may work in groups of two or three. Choose an area to work that has at least 2 meters of clear uniform floor space. Carpeted flooring is less desirable than tile. If needed, driving mats may be used as a driving surface.	• Masking tape • Drive mats

Student Activity	Teacher Activity
Challenge 1: Write a program named "**c1**" that uses right turns to spin Rover a total of 360 degrees.	**Guidance during challenge 1:** Review the TI-BASIC editor and how to run a program with students. • Basic navigation on the calculator. • Saving and opening files. • Editing new and existing programs. • Running programs. • Editing program features. • This first challenge should be done just after the RV RIGHT and RV LEFT commands are introduced and before introducing the angle argument for the commands. Do not yet, inform the students that an angle can be entered into the command. • As the students explore using the RIGHT and LEFT turns, challenge them to determine what angle the Rover is turning. Next, ask how many angle turns are needed to spin a circle? • Discuss and challenge students that are ahead how they could do the same program turning to the left. • See program c1, titled, "Unit 1 Skill Builder 2 U1SB2C1 Example Program.8xp" in the "Code" folder.
Challenge 2: Write a program named "c2" to turn Rover in a circle using the RIGHT or LEFT commands. After each turn, display the total angle turned from the starting point on the calculator screen.	**Guidance during challenge 2:** Review the usage of the Output(input/output (I/O) statement. • Enter the line number, 1 (top of screen) to 10 (bottom of screen) and the starting character 1 at the left of the line and 26 to the far right of the line. • Enter the display string in quotes " " • An example: Output(1,1, "Turn Angle is 90") Review the usage of the Wait command. • prgm-> : HUB-> 4: Wait • Enter the time in seconds to wait. • An example: Wait 2 • The Rover and the calculator perform at different speeds. When a drive command is sent to the Rover, it may require several seconds for the Rover to drive that command. The program must wait for the Rover to

finish before doing another command. The Wait command is used to tell the calculator to do nothing and just wait for the Rover to finish driving.

- Have the students explore the effect of using the Wait command in different places in their program and also with different times. It can be tricky to keep the Output in sync with the Rover's motion in order to achieve Challenge 2. Please refer to program c2, titled, "Unit 1 Skill Builder 2 U1SB2C2 Example Programs.8xp" in the "Code" folder for an example solution for this challenge.
- Discuss and challenge students who are ahead how they could do the same program in radians or gradians.

Challenge 3: Write a program named "**c3**" and use a For...EndFor loop to turn three circles to the right and then three circles to the left in steps of 90 degrees. Display the total of degrees turned by the Rover at each step on the calculator screen.

Guidance during challenge 3:

Review the usage of the For…End statement.

- prgm->CTL (control)->4:For(
- You will need two commas: For ,, These are delimiting punctuation characters for the three arguments of; index variable name, start value, and end value required in the command. To end the loop, add 'End' (prgm->CTL->7:End). An example of a For…End that does something 5 times is:

```
For(N,1,5)
  … do something five times
End
```

- Help the students to understand the difference between using the previous program which explicitly calls out each command and the use of the For…End loop which reuses one set of commands repeatedly. Also, inform students of the use of the index variable. This variable may be used to calculate the total angle turned by the Rover using the expression n*90, where n is incremented each time the For…End loop is iterated. See example program c3, titled, "Unit 1 Skill Builder 2 U1SB2C3 Example Program.8xp" in the "Code" folder.

Challenge 4: Write a program named "**c4**" that has Rover model the hour hand on a clock. Turn the Rover to stop at each hour of the clock. Display the value of the current hour on the calculator display.

Guidance during challenge 4:

- This challenge is the final challenge of this activity and requires that students incorporate all of the skills learned so far. Encourage student to look back through programs c1, c2, and c3 as references for creating this new program. Students may be curious of the fact that there are 24 hours in a day. This number, like 360 degrees in a circle, comes from the Babylonian sexagecimal system since 360/15=24. Se example program c4, titled, "Unit 1 Skill Builder 2 U1SB2C4 Example Program.8xp" in the "Code" folder.